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# Force Expansion Curves

## a way to model future capability

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<b>Report Documentation Page</b>			Form Approved OMB No. 0704-0188	
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1. REPORT DATE <b>01 OCT 2003</b>	2. REPORT TYPE <b>N/A</b>	3. DATES COVERED <b>-</b>		
<b>4. TITLE AND SUBTITLE</b> <b>Force Expansion Curves a way to model future capability</b>			5a. CONTRACT NUMBER	
			5b. GRANT NUMBER	
			5c. PROGRAM ELEMENT NUMBER	
<b>6. AUTHOR(S)</b>			5d. PROJECT NUMBER	
			5e. TASK NUMBER	
			5f. WORK UNIT NUMBER	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> <b>Defence Science and Technology Organisation, Defence Systems Analysis Division Australia</b>			8. PERFORMING ORGANIZATION REPORT NUMBER	
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>			10. SPONSOR/MONITOR'S ACRONYM(S)	
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
<b>12. DISTRIBUTION/AVAILABILITY STATEMENT</b> <b>Approved for public release, distribution unlimited</b>				
<b>13. SUPPLEMENTARY NOTES</b> <b>See also ADM001929. Proceedings, Held in Sydney, Australia on July 8-10, 2003., The original document contains color images.</b>				
<b>14. ABSTRACT</b>				
<b>15. SUBJECT TERMS</b>				
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b> <b>UU</b>	<b>18. NUMBER OF PAGES</b> <b>37</b>
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>		



## Other authors

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- Andrew Nicholls, Office of the Minister for Defence
- David Cox, Air Operations Division
- Richard Bartholomeusz, Air Vehicles Division



## Structure of talk

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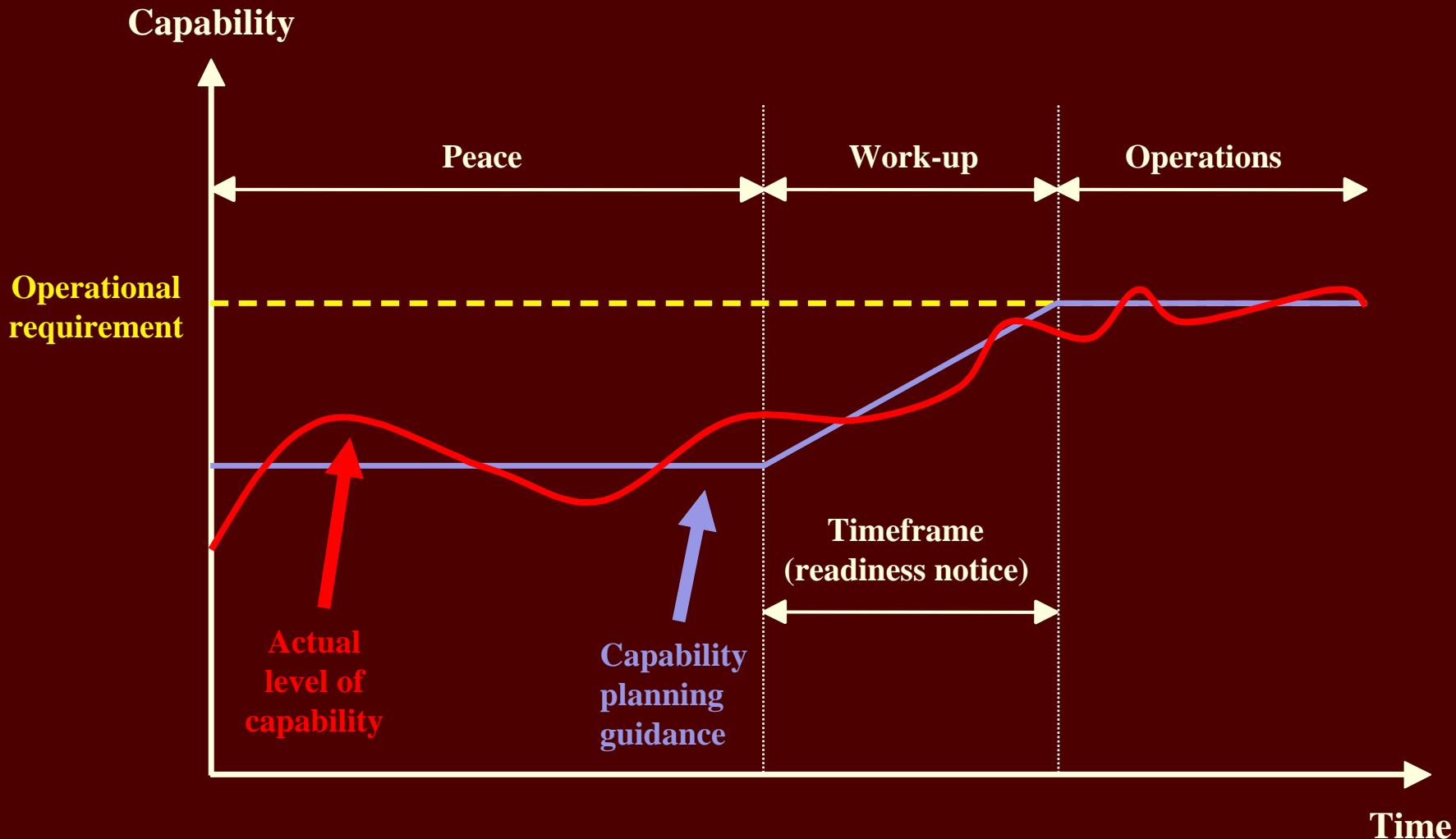
- How does the ADF manage capability?
- What are Force Expansion Curves?
- Case study: Maritime Patrol Group
- How can we use Force Expansion Curves?



# How does the ADF manage capability?



# Levels of capability





# What are Force Expansion Curves?



DEFENCE  
SCIENCE & TECHNOLOGY

# Motivat

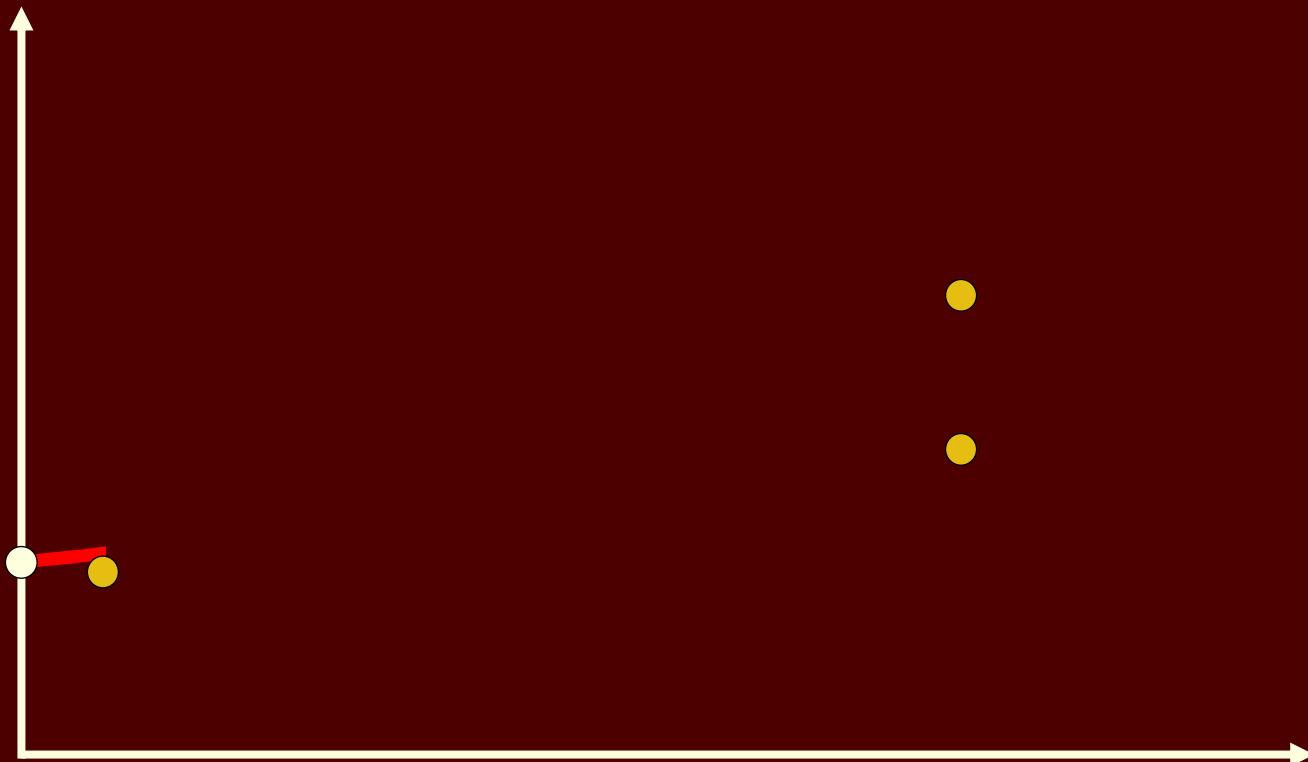
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## Motivating example

### Capability



Warning Time



DEFEND  
SCIENCE & TECHNO

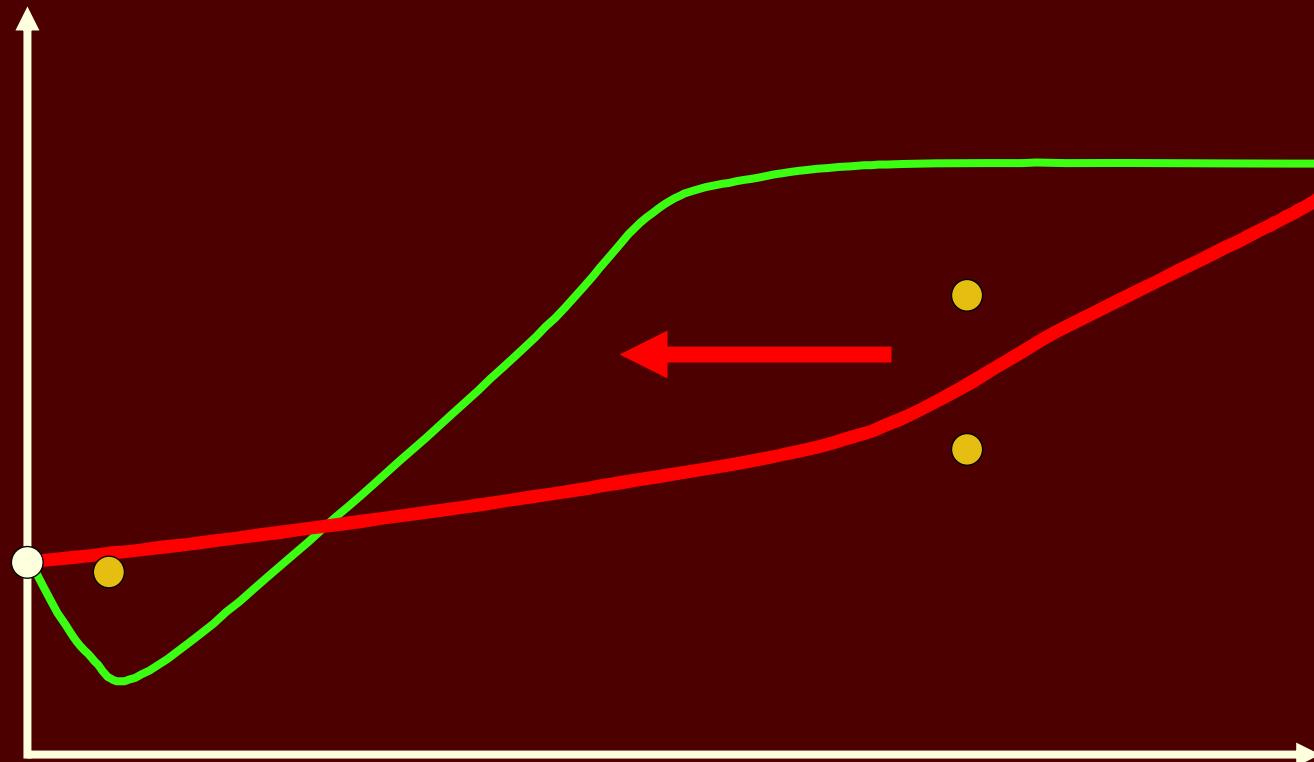
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## Motivating example

### Capability

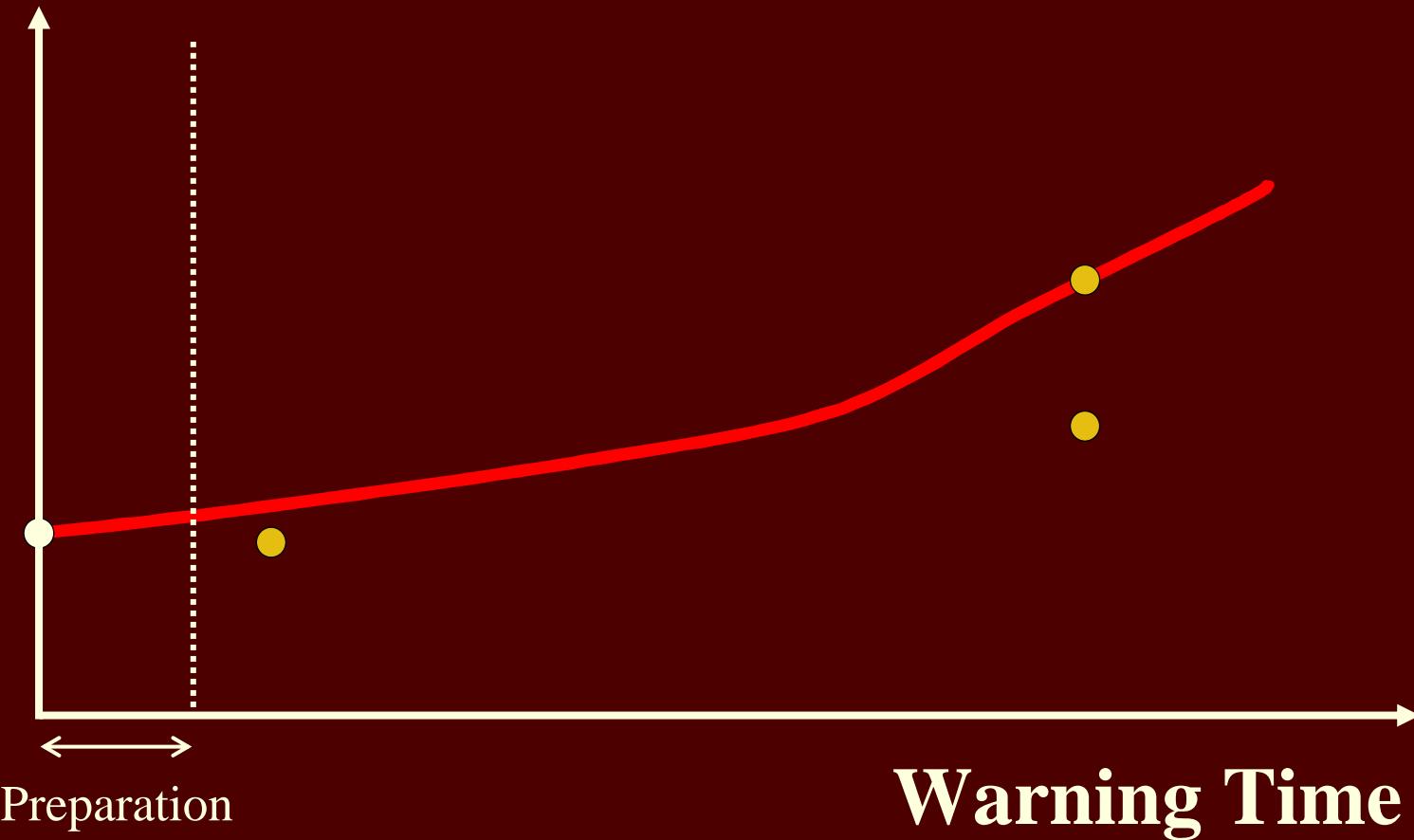


Warning Time



## Motivating example

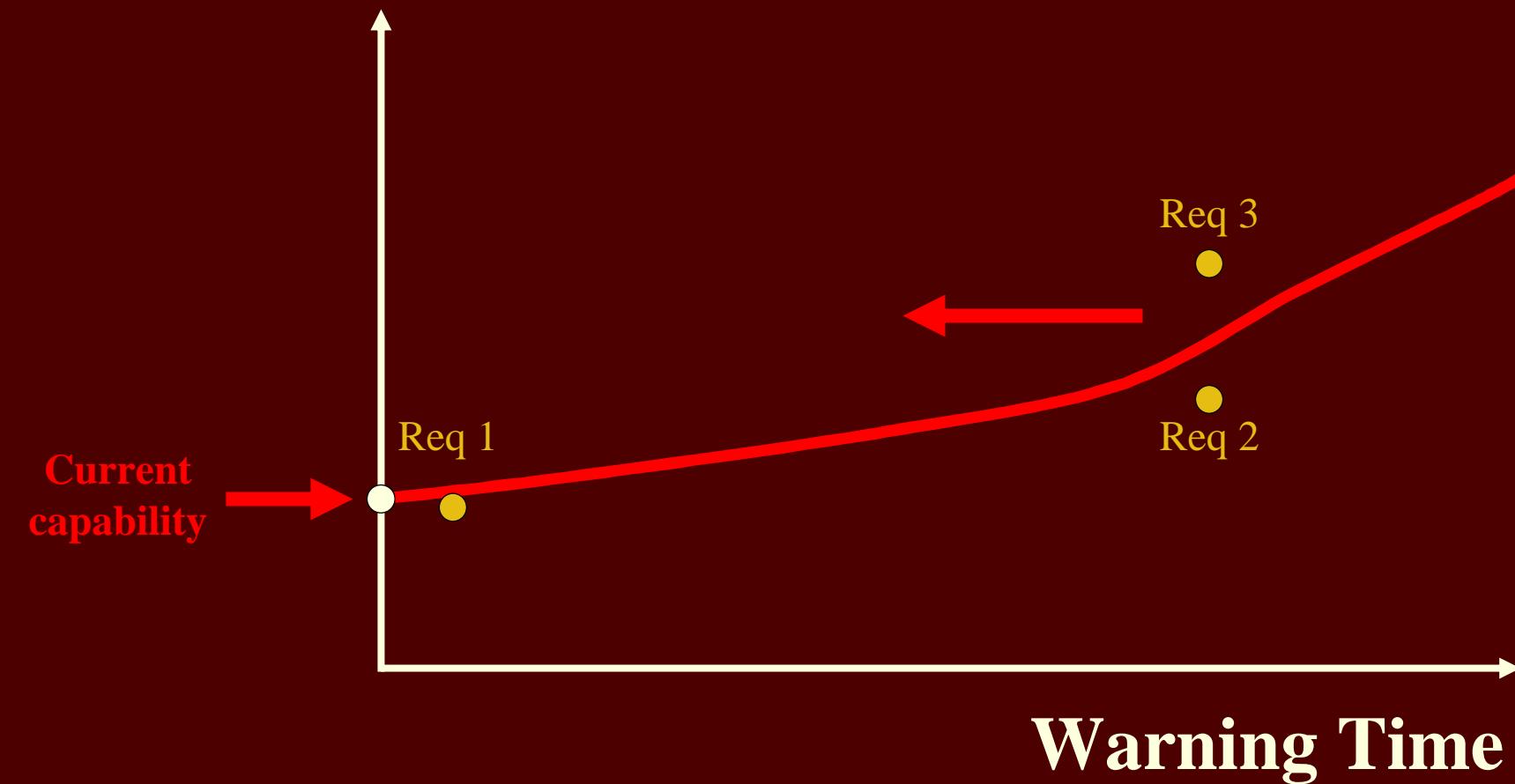
### Capability





## Military context

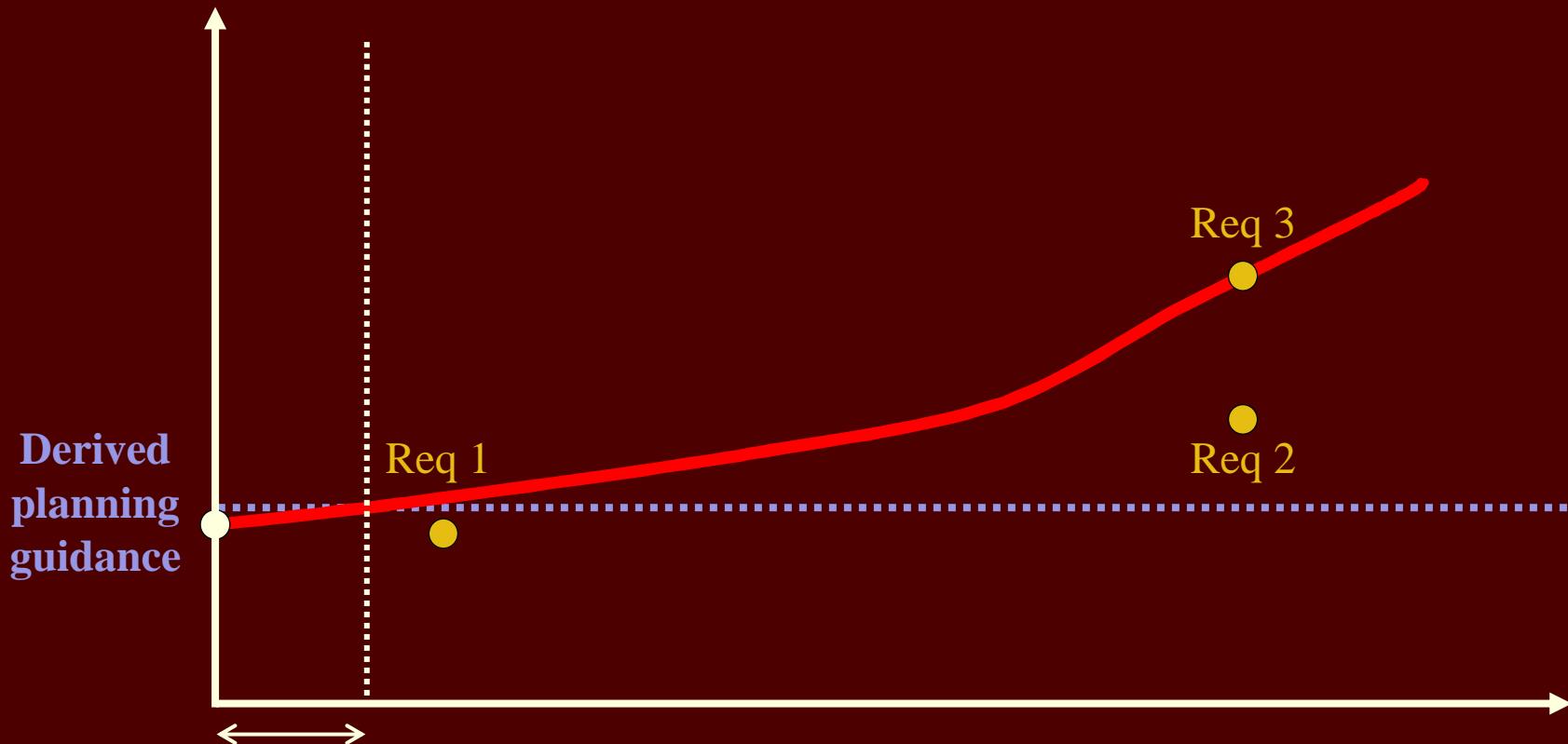
### Capability





## Military context

### Capability



Work-up period to address  
capability deficiency

Warning Time



## Key questions

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- How do we measure capability?
- How do we interpret strategic guidance?
  - Hard constraints (optimisation)
  - Soft constraints (goal programming)
- How do we create Force Expansion Curves?



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# Case study: Maritime Patrol Group





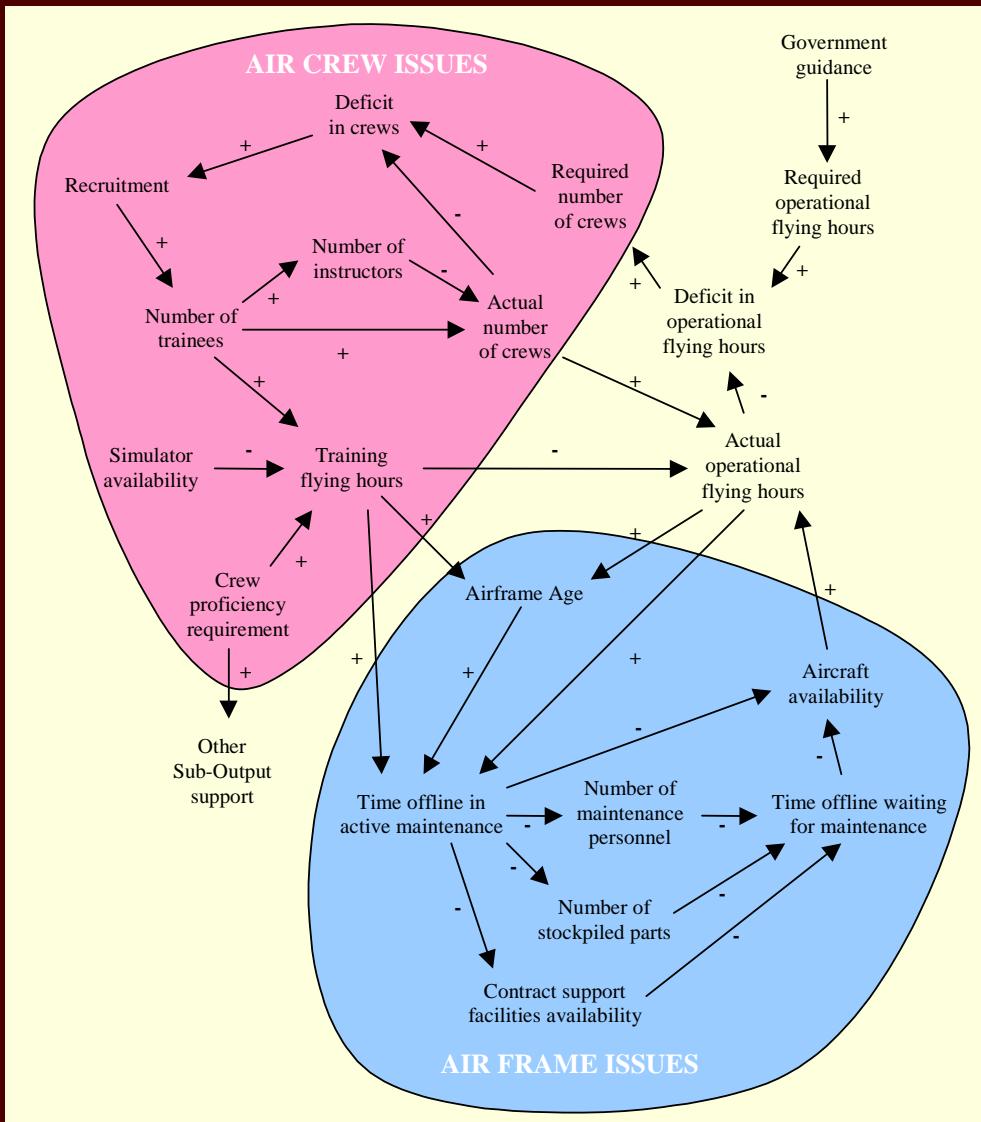
## Case study: Maritime Patrol Group

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- In 2000, DSTO study of preparedness recommends the development of Force Expansion Curves
- Maritime Patrol Group was chosen:
  - Continuity
  - Good data
  - Enthusiasm and support



# Influence Diagram





## General approach

- Simulate the crew training and posting cycle

Why did we break this up  
into two parts?

- Test the feasibility of the resulting flying program



## Variables and parameters

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- Capability measure: Number of crews
- Variables (controls):
  - Capacity of simulators
  - Number of instructors
  - Recruitment
  - Course lengths and posting lengths



## EXTEND

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- Simulation environment
- Both continuous time and discrete event models
- Features:
  - Good graphical user interface
  - Hierarchical blocks
  - Monte Carlo simulation
  - Sensitivity analysis
  - Heuristic optimisation (genetic algorithm)
  - Compatible with MS Excel



## Personnel Model

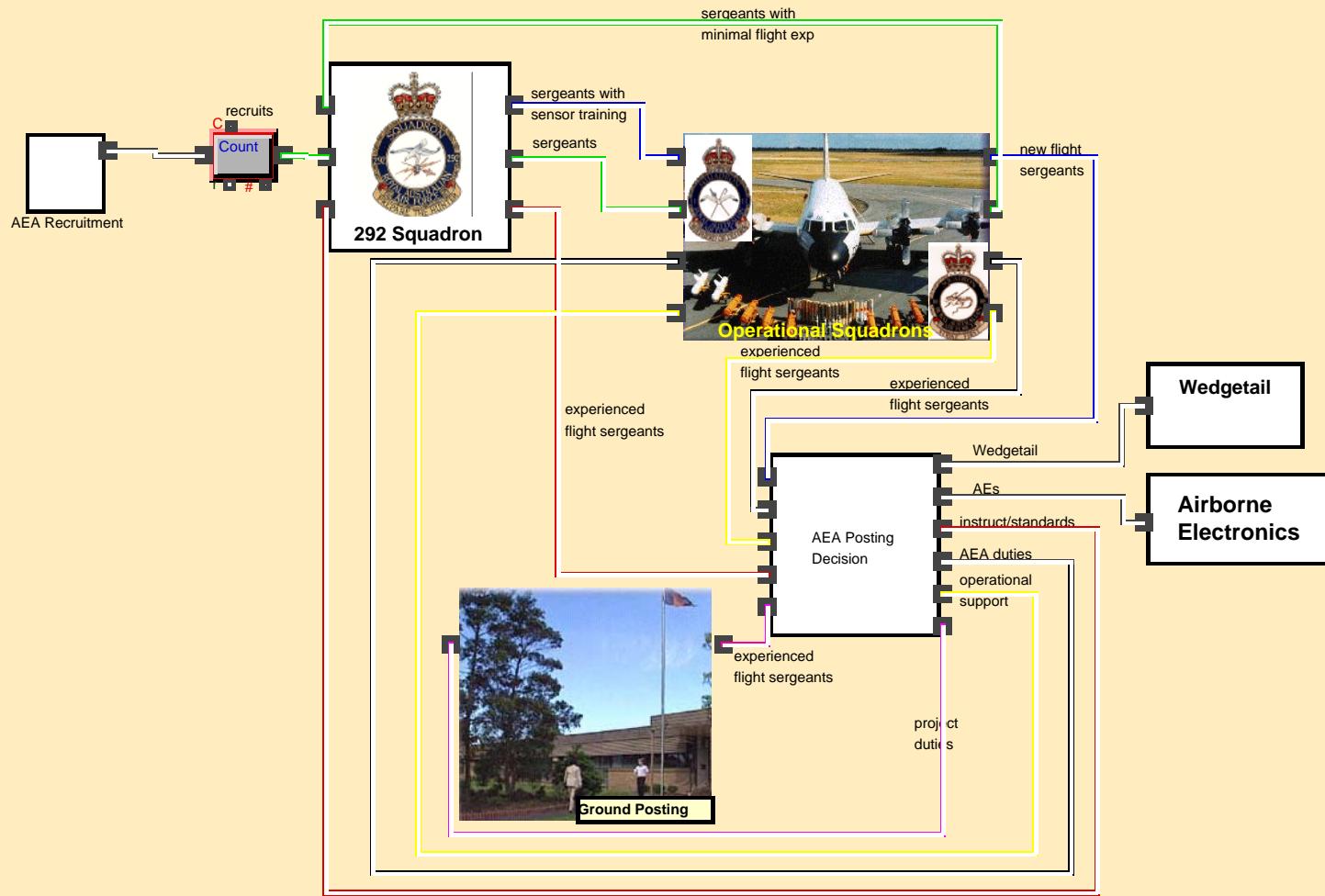
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- Personnel pipelines modelled as a production line
  - People modelled as items
  - Events modelled as machines
- Current and future MPG personnel practices are included



# Personnel Model

## Airborne Electronic Analysts





## Personnel Model

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- Crew:
  - 2 Pilots
  - 2 Navigators
  - 1 Airborne Electronics
  - 5 Airborne Electronic Analysts
  - 2 Flight Engineers



## Personnel Model

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- Each role has a separate module
  - Easily understood and validated
  - Caters to time limitations
- Roles combine into crews
- Other modules:
  - Initialisation
  - Controls
  - Outputs



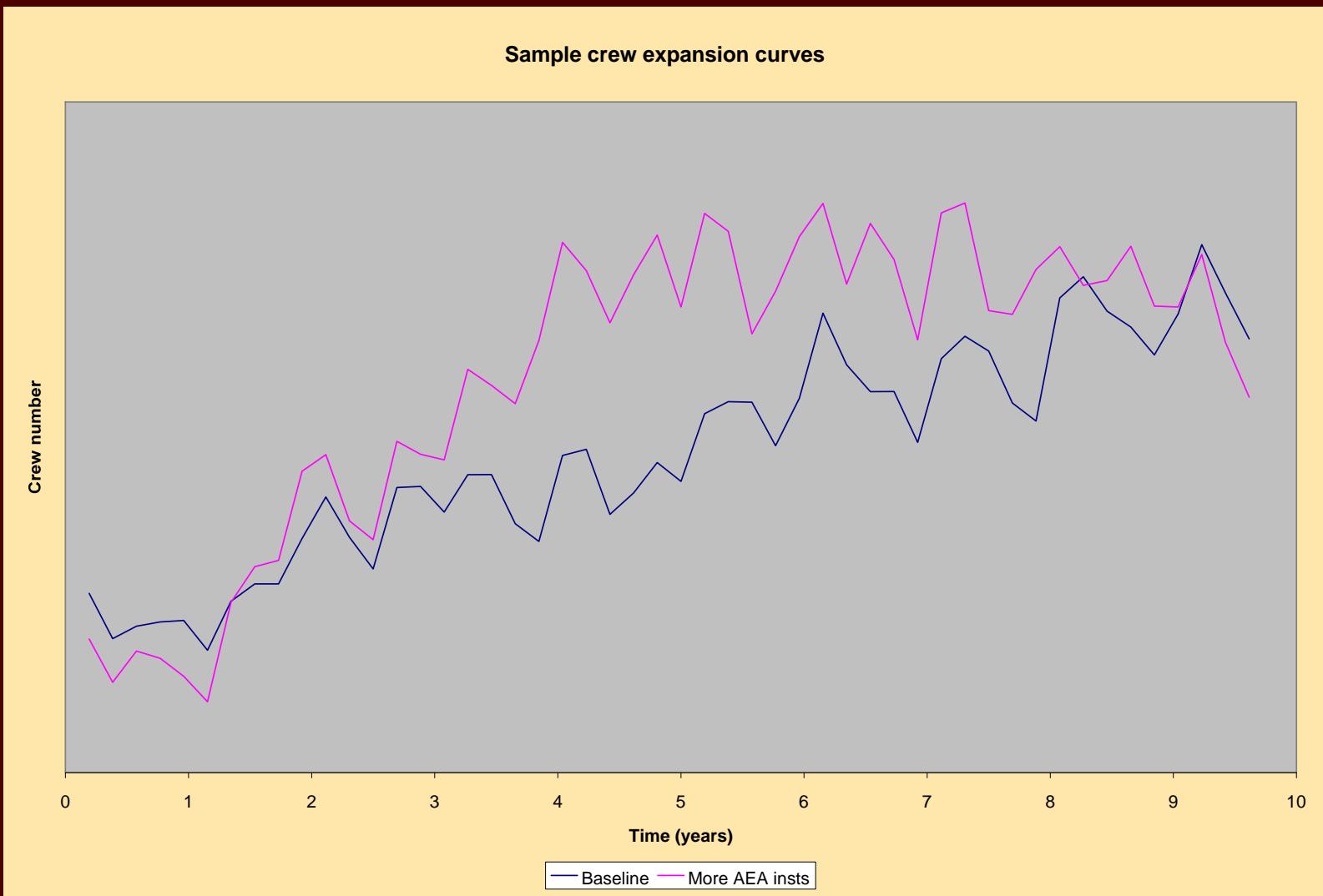
# Personnel Model

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- Predicts future crew levels
  - Baseline: current personnel practices
  - ‘What if’ analysis: altered system
- Indicates critical factors and bottlenecks



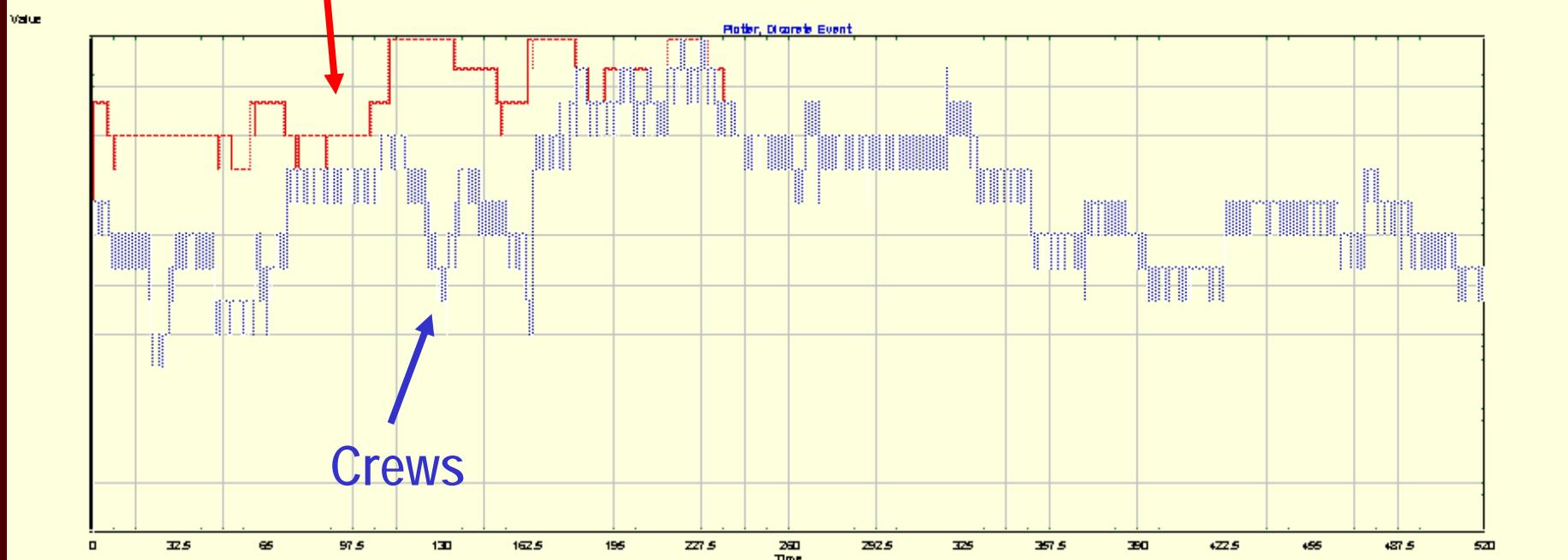
# Sample Personnel Results





# Sample Personnel Results

Airborne Electronics





## ASTOR

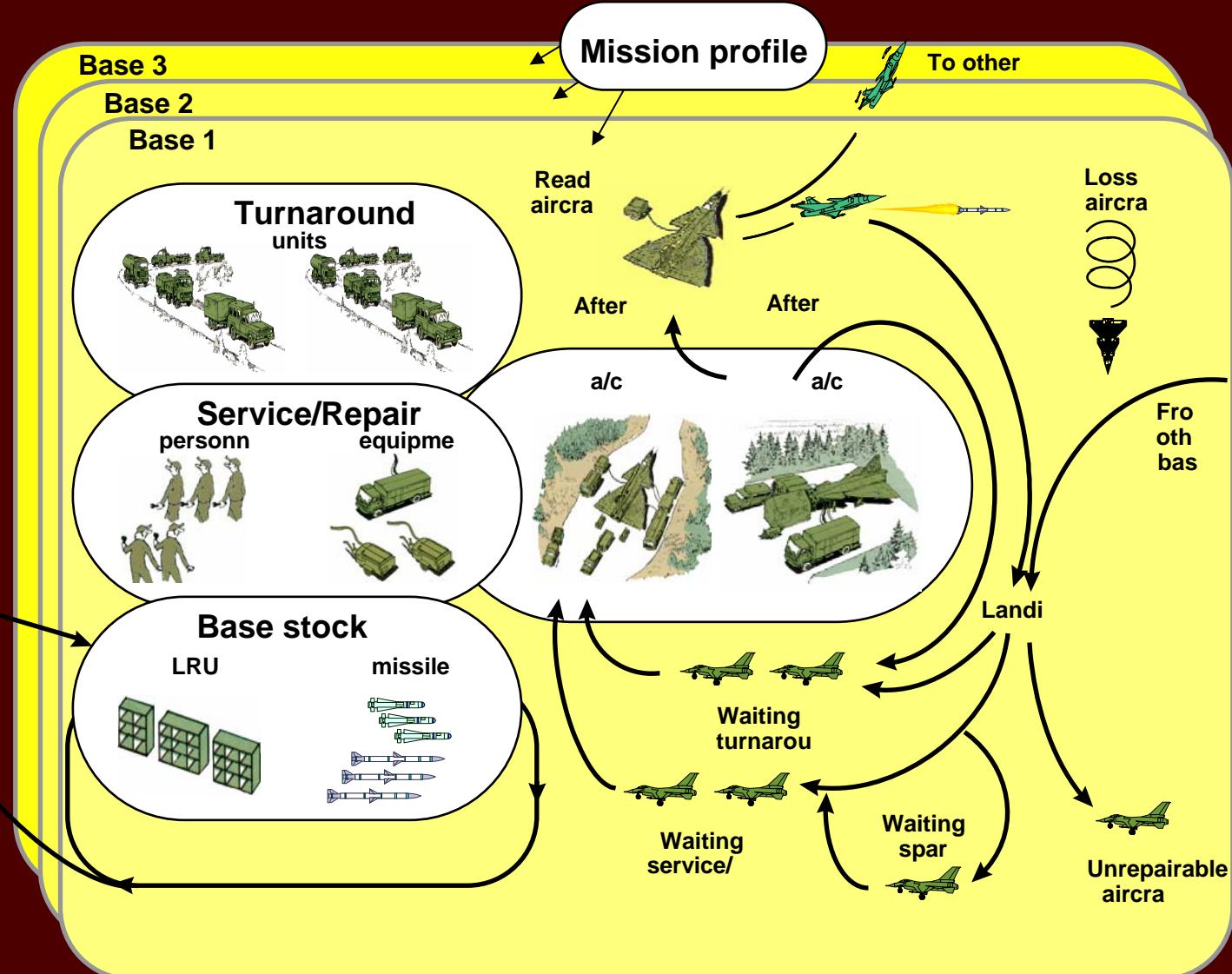
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### Air Force Simulation of Tactics and Operational Resources

- Developed by the Swedish Air Force and the RAAF
- Used by MPG to manage P-3C logistics
- Tests a predetermined flying program for feasibility
- Constraints:
  - Maintenance crews
  - Maintenance equipment
  - Spare parts
  - Aircraft reliability



# ASTOR





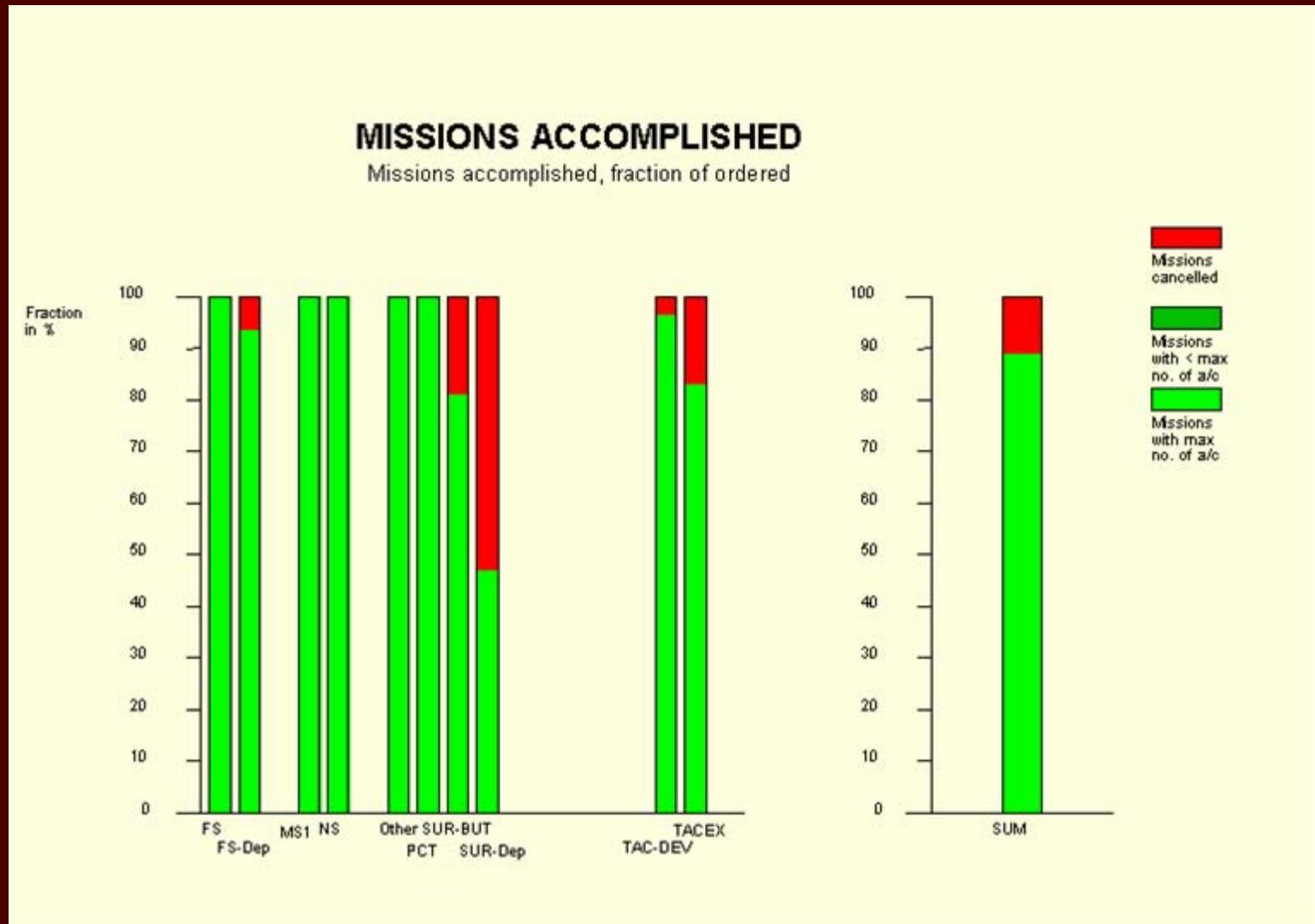
# ASTOR

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- Outputs:
  - Aircraft availability
  - Proportion of missions accomplished
  - Spare parts consumption
  - Repair and maintenance time

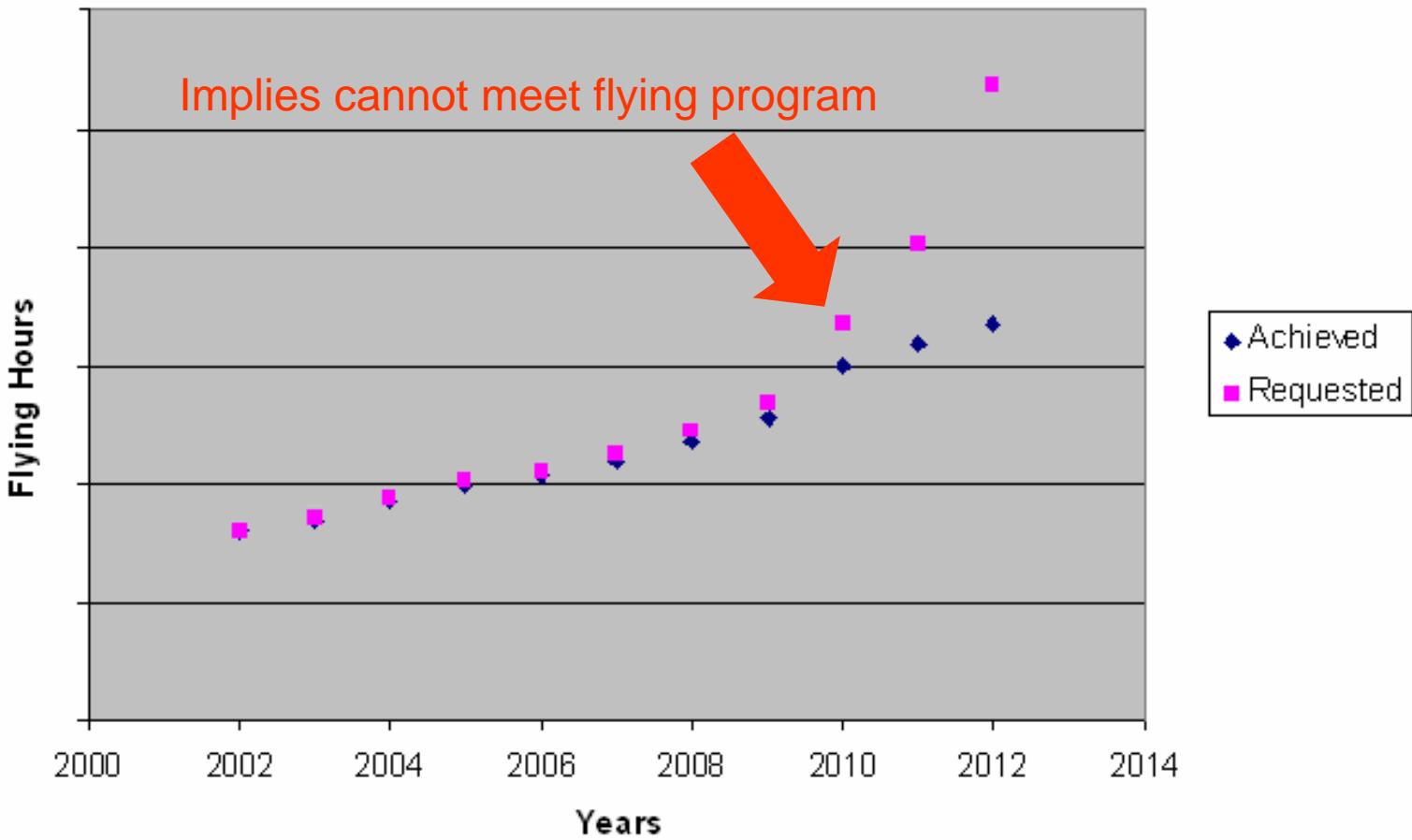


# Sample ASTOR results





# Using ASTOR to Support the Personnel Model



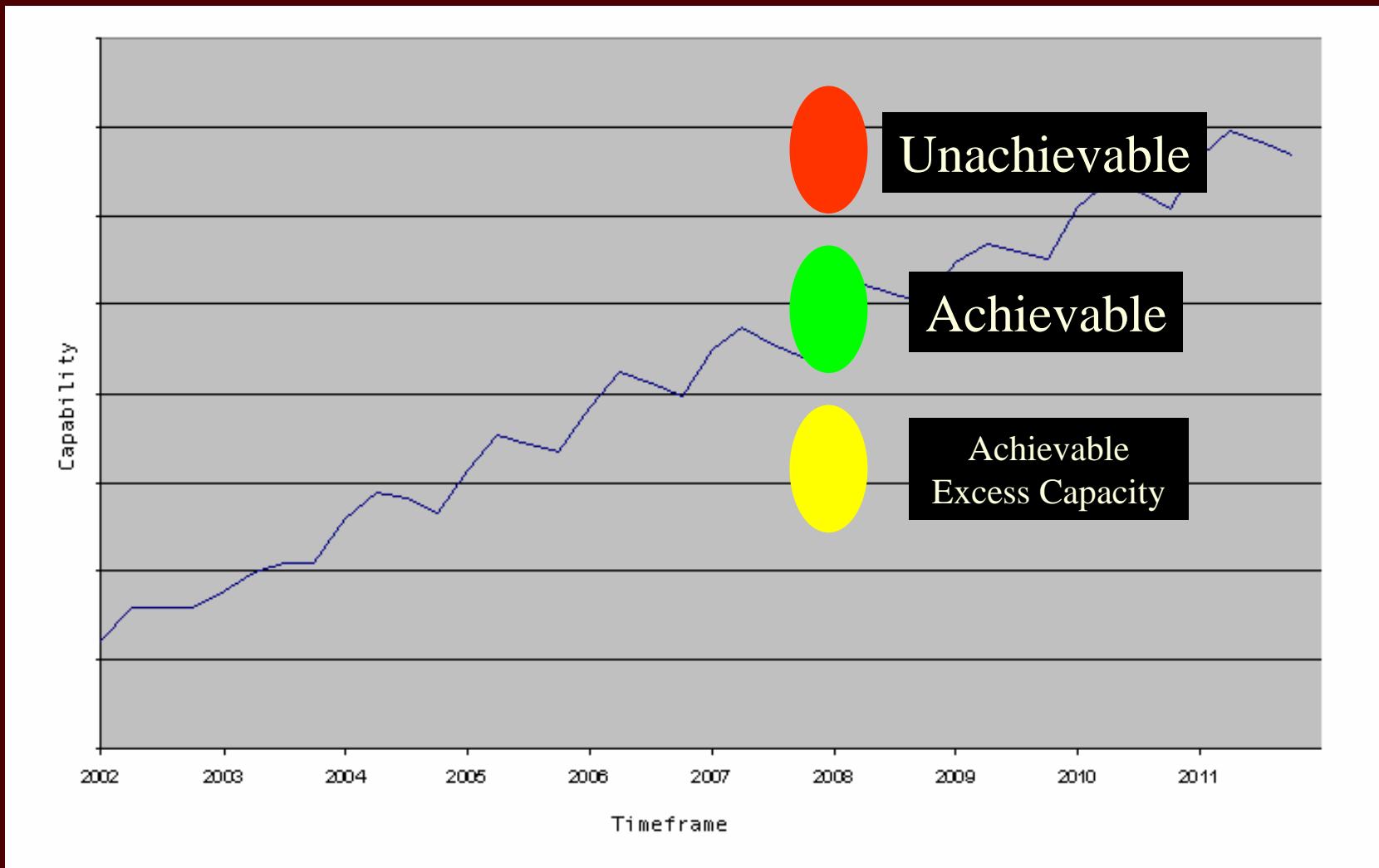


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# How can we use Force Expansion Curves?



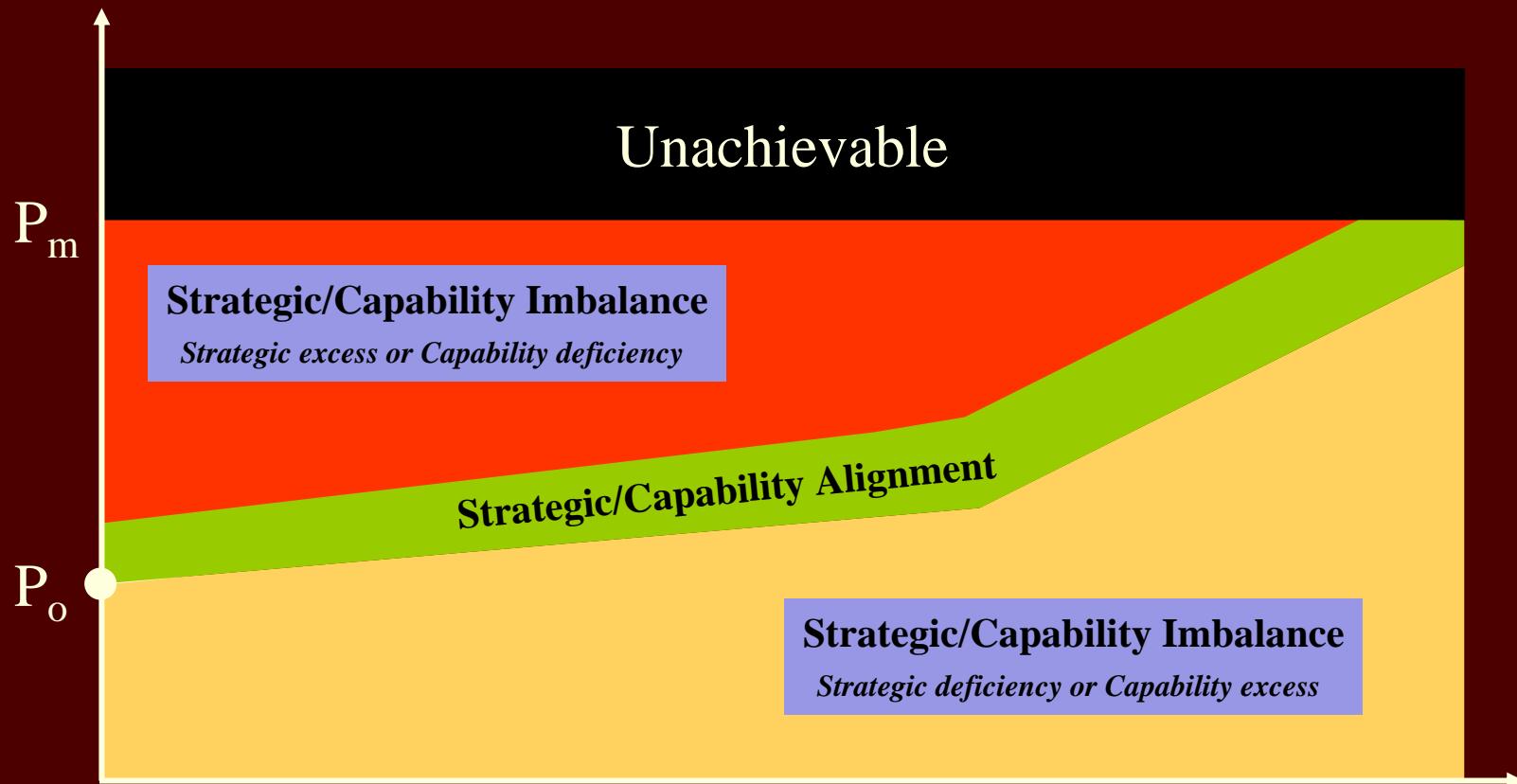
# Assistance to medium term preparedness planning





# Assistance to medium term preparedness planning

## Capability



$P_o$  Current Capability

$P_m$  Maximum Achievable Capability

Warning Time



## Conclusions

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- Force Expansion Curves can improve capability management by:
  - Illustrating different expansion strategies
  - Demonstrating rate and extent of expansion
  - Quantifying the effect of controls
  - Allowing costing of different options